

SKINFOLD MEASUREMENTS IN YOUNG AMERICAN  
MALES

BY RUSSELL W. NEWMAN

REPRINT FROM

**HUMAN  
BIOLOGY**  
a record of  
research

MAY, 1956

Vol.  
28



No.  
2

Published Quarterly by  
WAYNE UNIVERSITY PRESS,  
Detroit 1, Michigan,  
U. S. A.



## SKINFOLD MEASUREMENTS IN YOUNG AMERICAN MALES

BY RUSSELL W. NEWMAN

*Quartermaster Research and Development Command,  
Natick, Massachusetts*

### INTRODUCTION

THE growing use of skinfold measurements obtained with constant-pressure calipers has emphasized the need for large-scale surveys of selected populations to develop standards against which future studies can be compared. No single survey will be adequate in this field, even within one population, because age (Brožek, '52), sex (Škerlj, Brožek, and Hunt, '53), and physical activity differences (Brožek, '54) will require subsampling beyond the capacity of most surveys. This report is not definitive, even in its selected sample of young American adult males, but it should provide data more extensive than presently available.

The sample reported here consists of approximately 2,400 young men measured shortly after induction into the U. S. Army and before the start of basic training. Two thousand of these were re-measured after 6 or 7 weeks of training and an analysis of the changes which occurred in these men will be reported later. The series used here consists of 2,017 American-born White males and 361 American Negro males. Certain comparisons between these racial groups have been published (Newman, '55). It was concluded that no great error was introduced by using the same regression equation for converting skinfold measurements to body fat, although the original equation was based solely on White college students.

This report will cover two aspects of the skinfold measurements obtained on these men. One, the basic statistics on the measurements will be presented for the use of other workers in the field. Two, geographical and racial groups will be contrasted to show interesting differences between regional subsamples.

The measurements were collected at 7 Army basic-training centers in the eastern and southern portions of the country, from Maryland to Arkansas. Because it was necessary to resurvey the men before the end of basic training, no western centers could be visited in the time available. The men were not individually selected for this survey, entire training units of company size being processed at each installation. The sample consists of volunteers and of men inducted into the Army through Selective Service from the eastern half of the country during the spring of 1953. It is a series which has been medically screened for military service, with very short and tall men as well as the very light and heavy individuals eliminated. The age distribution of the series is relevant because of the well-known relationship of increasing fat with age. The mean age of the Whites was 20.7 years while that of the Negroes was 20.8. The variability of age was restricted (17 to 28 years old), as might be expected in a sample of military inductees.

The geographical restrictions of the sample will be apparent when regional area comparisons are presented later in this paper. Only 21 individuals are represented from the area west of the Great Plains. It is possible that the inclusion of a proportional sample from this area might alter the statistics on skinfold measurements and derived body fat, but it is doubtful that a radical revision would be required.

### STATISTICAL VALUES FOR THE RACIAL SERIES

Ten measures have been used in the analyses. Seven of these (stature, weight, and 5 skinfolds) were taken on the men and three (relative weight, fat-free weight, and body fat) were calculated from the data. Stature was recorded as the maximum height to which the subject could stretch with the feet firmly on the ground and the head and eyes level. Weight was obtained on the nude subjects with a physician's type scale. The skinfold measurements have been described in a previous paper (Newman, '55). Relative weight, *i. e.*, actual body weight expressed as percentage of the so-called "standard" weight for height and age, was calculated from the data provided by the medico-actuarial mortality investigation of 1912 as given in Davenport ('23). The limitations of this standard in terms of body composition have been shown by Brožek and Keys ('50) and its doubtful applicability to a military population pointed out (Newman, '52). It has been included here because it remains a common standard even if an outmoded one. Body fat was calculated by the formula of Brožek and Keys ('51). Fat-free weight is body

TABLE 1  
Presentation of White and Negro measures

2,017 Whites													
	Mean	S. D.	PERCENTILE										
			5th	25th	50th	75th	95th						
Stature (in)	68.9	2.5	65.0	67.2	68.9	70.6	73.2						
Weight (lb)	154.0	22.7	122.0	138.1	151.4	166.3	195.5						
Relative weight (percent)	105.2	13.7	87.6	96.5	103.5	112.6	131.4						
Fat free weight (lb)	142.1	15.0	118.0	131.0	141.5	152.6	168.3						
Body fat (percent of wt)	7.4	5.1	2.2	3.8	5.8	9.3	17.9						
Chest skinfold (mm)	10.0	6.6	4.4	6.4	8.6	11.9	23.6						
Arm skinfold (mm)	11.4	5.4	5.2	8.0	10.7	14.6	22.2						
Back skinfold (mm)	13.6	6.0	8.2	10.3	12.1	16.1	25.9						
Knee skinfold (mm)	15.0	5.8	8.5	11.2	14.4	18.5	26.4						
Abdomen skinfold (mm)	14.6	7.9	6.9	9.5	12.6	18.5	31.8						

361 Negroes													
	Mean	S. D.	PERCENTILE										
			5th	25th	50th	75th	95th						
Stature (in)	68.3	2.6	64.2	66.7	68.2	69.8	72.8						
Weight (lb)	151.0	18.5	122.9	139.3	148.8	161.8	183.3						
Relative weight (percent)	105.4	10.9	91.1	98.3	104.5	111.9	124.3						
Fat free weight (lb)	144.5	14.9	121.1	133.9	143.4	154.4	169.4						
Body fat (percent of wt)	4.6	3.4	1.1	2.7	3.7	5.5	10.0						
Chest skinfold (mm)	6.5	3.7	4.1	4.9	5.9	7.8	12.0						
Arm skinfold (mm)	8.2	4.0	4.4	6.1	7.8	10.0	15.8						
Back skinfold (mm)	12.2	4.3	8.3	10.2	11.6	14.0	21.2						
Knee skinfold (mm)	12.9	4.5	7.9	10.2	12.5	16.0	21.4						
Abdomen skinfold (mm)	11.7	5.7	6.5	8.7	10.6	13.6	25.0						

weight minus the calculated weight of the fat; it has been equated with the lean body mass (Behnke, '41).

The usual statistics on the racial samples are presented in table 1. Percentiles have been included along with the mean and standard deviation because those variables which include body fat are definitely skewed. A visual comparison of the means and medians (50th percentile) shows that only stature is truly symmetrical in distribution, with fat-free weight approaching symmetry.

#### RACIAL COMPARISON

It is apparent that the racial groups differ considerably in the amount of body fat. This has been graphically illustrated in figure 1 by plotting smoothed-curve distributions for body fat in terms of percentage frequency to equalize the numerical representation of the groups. The Negroes are not only more lean than the Whites, but their frequency distribution is remarkably narrow.

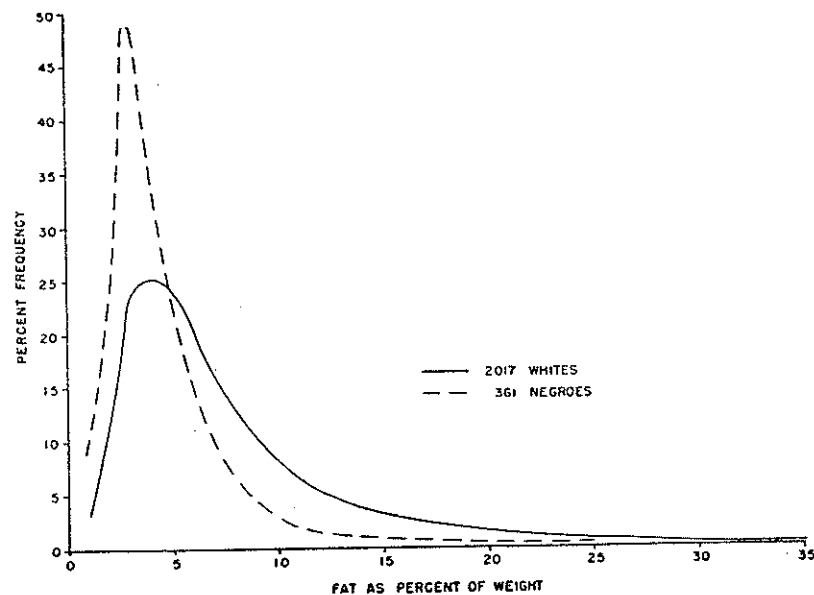


FIG. 1. DISTRIBUTION OF BODY FAT.

The statistical significance of the differences between the White and Negro mean values has been investigated by the use of Student's *t*-test. Unfortunately, this test presumes a "normal" distribution in both groups, a condition which is not fulfilled in most of these measures. Also, the large numbers of individuals involved result in statistical significance for minute differences which can have no biological meaning. All measures listed in table 1 show statistically significant differences at the 1% level except relative weight. Three of the measurements, body fat, chest skinfold, and arm skinfold, showed "*t*" values of much higher magnitude, indicating maximum differences in these variables. Since body fat is calculated from the measured thickness of chest and arm skinfolds (plus abdominal skinfold), it is these sites of subcutaneous fat which appear most distinctive between the racial groups. This phenomenon was noted in another type of analyses on this series and a possible explanation presented (Newman, '55).

#### REGIONAL COMPARISONS

In the following regional subsamples of these racial groups the analyses have been conditioned by the geographical distribution available in the series. It was necessary to select regional groupings which provided reasonable environmental and historical continuity without unduly reducing the sample size. Although no geographic selection which uses political boundaries can completely satisfy biological analyses, a regional grouping of states where the men were born was essential, and the Selective Service areas utilized in previous Quartermaster Corps anthropometric surveys were selected. These areas are shown in figure 2. Two regions, the Mountain States and the Pacific Coast, have not been included for lack of adequate representation.

#### NORTHERN AND SOUTHERN WHITES

A two-fold grouping of the White subjects into Northern and Southern is a convenient breakdown of the 7 regions shown in figure 2. Four northern regions (New England, Middle Atlantic, East and West North Central) and three southern regions (South Atlantic, East and West South Central) delineate the traditional boundaries. The means and standard deviations of the regional groupings are shown in table 2.

Within the same limitations mentioned in the Negro-White comparisons and with some doubt as to their applicability, a *t*-test of mean

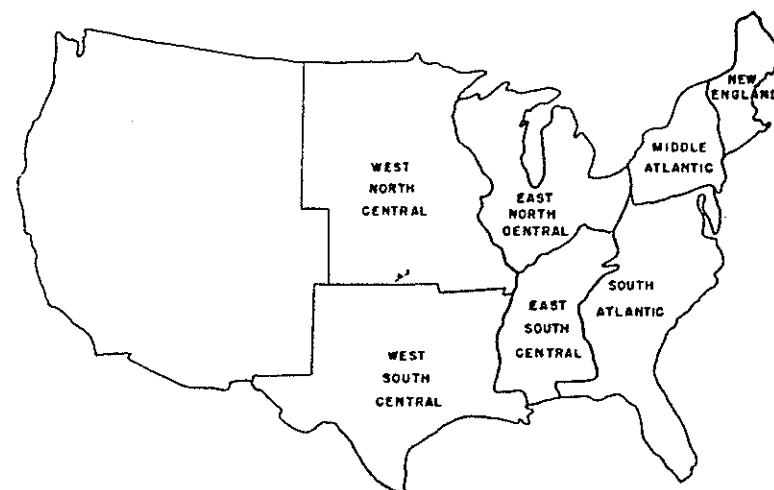


FIG. 2. REGIONAL GROUPING OF NATAL STATES.

TABLE 2

*Comparison of Northern and Southern Whites*

	1,283		713	
	NORTHERN WHITES		SOUTHERN WHITES	
	Mean	S. D.	Mean	S. D.
Stature (in)	69.0	2.5	69.0	2.5
Weight (lb)	156.3	23.5	150.3	20.8
Relative weight (percent)	107.4	14.0	103.0	12.9
Fat free weight (lb)	143.4	15.8	139.9	15.0
Body fat (percent of wt)	7.9	5.3	6.4	4.6
Chest skinfold (mm)	10.6	6.9	9.0	5.7
Arm skinfold (mm)	12.0	5.6	10.4	5.0
Back skinfold (mm)	14.2	6.4	12.4	5.2
Knee skinfold (mm)	15.7	6.0	13.9	5.4
Abdomen skinfold (mm)	15.3	8.2	13.4	7.1

difference indicated statistically significant differences such as were found between Whites and Negroes. Except for height, the southerners have uniformly lower values, including both fat-free weight and those measures influenced by body fat. This indicates that the sizable weight difference (6 pounds) is not solely a matter of leanness-fatness; the southerners are lightly built with a demonstrably paucity of muscular tissue.

#### NORTHERN AND SOUTHERN NEGROES

An investigation of the Negroes on the basis of birthplace is complicated by two problems; one, over 80% of the Negroes were born in the south; and, two, there was an expectably large number of Negroes who were born in the south but who entered the Army at northern induction centers. For these reasons, the Negroes were separated into 4 groups on the basis of birthplace and induction center. Since it is apparent that body fat is the crucial element of geographical differences, only this variable has been used; the data are presented in table 3.

TABLE 3

*Comparison of Northern and Southern Negroes in terms of body fat (as percentage of weight), estimated from skinfolds*

	PERCENTAGE OF		BODY FAT	
	361 Negroes	Number	Mean	S. D.
Born in the south; inducted in the south	66	239	4.2	2.6
Born in the south; inducted in the north	15	53	4.9	3.7
Born in the north; inducted in the north	18	64	5.4	4.0
Either birthplace; inducted in the north	33	117	5.2	3.9

It will be noticed that one possibility was omitted in this table: Negroes who were born in the north and were inducted in the south. Only 5 individuals fell into this category and this was much too small a sample for comparative purposes. It was not determined at what age the individuals born in the south but inducted in the north migrated or whether their residence was continuous. The *t*-test showed no statistically significant mean difference in body fat between the southern Negroes on the basis of place of induction, but those born and inducted in the north differed from those born and inducted in the south at the 5% level of significance. Negroes inducted in the north, regardless of

birthplace, differed significantly at the 5% level from those inducted in the south. This set of comparisons suggests either that a selective migration has occurred or that the northern environment (climatic, cultural, economic) leads to greater fat deposition. The findings on Negroes who were born in the south and inducted in the north, although not significantly different in body fat from those who remained in the south, strengthen the latter hypothesis.

#### REGIONAL COMPARISON IN WHITES

The large number of White soldiers available from the geographic regions shown in figure 2 can be listed by area and still maintain adequate samples. Only two regions, New England and West South Central, are sparsely represented. The means and standard deviations for the regional groups are given in table 4.

This table gives some idea of the proportional representation which went into the north-south comparison in table 2. There is a suspicion which would be difficult to verify because of the unequal numerical representation of the states that a band of relatively great obesity with medium muscularity stretches from New Jersey to Chicago and that this contrasts with a parallel band of leanness and low muscularity in what might be called the Deep South. New England and the Plains States appear peripheral to these concentrations of fatness and leanness but high in fat-free weight (muscularity). Hooton ('48) reached this conclusion in an analysis of body-build photographs of approximately 40,000 U. S. Army men. He found that the Middle Atlantic region had the highest concentration of fat men, and the highest percentage of what he termed muscular types occurred in New England. He ascribed the origin of the two diverse belts of body composition to the importance of national extraction. He says:

Clearly the principal reasons why the Middle Atlantic and New England districts show such profusions of the well-muscled types and why the former district is so high in heavy men have to do with the population of recent foreign origin in these industrialized areas, which includes so many Southern, Eastern, and Central Europeans. These countries provide excesses of short, stocky, muscular men—even down to the second generation born in this country. On the other hand, districts such as Southern Atlantic and East South Central are mostly Old American (which implies mainly British and Irish derivation) and, consequently, the slender, tallish types of lighter musculature are likely to come in disproportionately large numbers from such regions.

TABLE 4  
Regional values for White soldiers

	NEW ENGLAND	MIDDLE		EAST		WEST		SOUTH		EAST		WEST	
	Mean S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Stature (in)	69.8	68.8	2.4	68.5	2.6	69.1	2.4	69.0	2.6	69.0	2.2	68.9	1.4
Weight (lb)	155.7	137.2	24.2	155.4	23.6	157.6	19.9	150.7	22.0	149.3	19.4	152.1	18.0
Relative weight (percent)	104.7	108.6	16.0	107.0	13.5	107.9	12.1	103.2	13.2	102.1	11.6	103.7	10.5
Fat free weight (lb)	144.9	143.7	16.0	142.6	16.3	144.8	14.0	140.4	15.6	139.0	13.9	140.8	15.0
Body fat (percent of wt)	7.0	4.1	8.0	5.0	8.0	5.3	7.6	0.4	4.6	6.4	4.5	7.0	4.6
Chest skinfold (mm)	10.0	5.4	11.2	7.5	11.4	7.1	10.8	9.3	5.7	9.5	5.5	10.1	6.0
Arm skinfold (mm)	11.5	4.5	12.8	6.2	12.5	5.4	12.4	10.8	5.0	10.8	5.0	11.6	4.6
Back skinfold (mm)	13.1	5.0	14.8	6.9	15.0	6.4	14.5	12.9	5.3	12.8	5.0	13.8	5.3
Knee skinfold (mm)	15.3	4.9	16.1	7.1	16.2	5.7	16.5	14.1	5.8	14.8	5.5	14.7	5.0
Abdomen skinfold (mm)	14.7	6.4	15.7	8.6	16.1	8.3	15.5	13.9	7.2	13.8	6.9	14.4	7.0
Number	87	328	637	231	407	254	52						

This hypothesis is difficult to reconcile with the data on Negroes shown in table 3 since there can be little question of subracial or national extraction influencing the north-south difference in body fat with this group. Several other causes are possible, such as climatic, economic, or nutritional background, and the relationships between these factors and a much larger U. S. Army series for which body weight was available have been discussed recently (Newman and Munro, '55).

## SUMMARY AND CONCLUSIONS

Skinfold measurements and derived measures of body composition were obtained on a large series of young White adult males and a smaller series of young American Negro males. The limited age range and possible effects of military selection may restrict the applicability of the data for other purposes but not the internal reliability for comparisons. A racial contrast emphasized the leanness of the young Negro male and his distinctive deficiency of subcutaneous fat over the pectoral and triceps regions. Geographic grouping of the men indicated a regional difference between northerners and southerners in the amount of body fat for both Whites and Negroes. The causes of these differences in body fat are not fully clear but their relevance to human nutritional and ecological research is obvious.

## LITERATURE CITED

- BEHNKE, A. R. 1941-42 Physiologic studies pertaining to deep-sea diving and aviation, especially in relation to fat content and composition of the body. Harvey Lectures Ser. 37: 198-226.
- BROŽEK, J. 1952 Changes of body composition in man during maturity and their nutritional implications. Fed. Proc., 11: 784-793.
- 1954 Physical activity and body composition. Arhiv za Higijenu Rada. (Arch. Industr. Hyg.), Zagreb, 5: 193-212.
- BROŽEK, J. AND A. KEYS 1950 Limitations of the "normal" body weight as a criterion of normality. Science, 112: 788.
- 1951 The evaluation of leanness-fatness in man, norms and interrelationships. Brit. J. Nutr., 5: 194-206.
- DAVENPORT, C. B. 1923 Body Build and Its Inheritance. Publ. Carnegie Instn., No. 329.
- HOOTON, E. A. 1948 Body Build in Relation to Military Function in a Sample of the United States Army. Prepared for the Office of The Quartermaster

- General. From the Department of Anthropology, Harvard University, Cambridge, Mass.
- NEWMAN, R. W. 1952 The Assessment of Military Personnel by 1912 Height-Weight Standards. The Office of The Quartermaster General, Research and Development Division, Environmental Protection Branch Report No. 194.
- 1955 Skin-fold changes with increasing obesity in young American males. *Human Biology*, 27: 53-64.
- NEWMAN, R. W. AND E. H. MUNRO 1955 The relation of climate and body size in U. S. males. *Am. J. Phys. Anthropol.*, n.s. 13: 1-17.
- ŠKERLJ, B., J. BROŽEK AND E. E. HUNT, JR. 1953 Subcutaneous fat and age changes in body build and body form in women. *Am. J. Phys. Anthropol.*, n.s. 11: 577-600.

